ORIGINAL RESEARCH

Injury Analysis in Professional Soccer by Means of Media Reports – Only Severe Injury Types Show High Validity

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Purpose: Injury data of professional soccer players obtained from media reports are frequently used in scientific research, but the accuracy of such data is still unclear.

Patients and Methods: Injuries of professional soccer players of the German first and second league were documented by continuously screening media reports over one season (2015–2016). After the season, the validity of media-reported injuries was anonymously analyzed by the team physicians of 8 different soccer clubs.

Results: A total of 255 injuries of 240 players of 8 professional soccer teams had been published online, of which 146 were confirmed by the team doctors as correct, yielding a rate of 57.3% of confirmed media-reported injuries. In addition, 92 injuries without media registration were detected and added to the online statistics, resulting in 347 injuries and an overall weak validity of media-based data of 42.1%. Statistical analysis showed that the validity of media-reported injury data depended on both the individual soccer club and the body site affected by injury: publications on knee injuries (78.2%) had a higher validity than those on foot injuries (46.2%), and publications on severe injuries had a higher validity (joint dislocation: 100%; ligament rupture: 82.9%; fracture: 73.3%) than those on minor injuries. Publications on specific severe soccer injuries, such as anterior cruciate ligament (ACL) injuries, had a validity of 100%.

Conclusion: Media-based injury data were only valid for a few severe injury types such as ACL injuries. In daily soccer routine and scientific research, media-based data should thus only be used in combination with specific criteria or verification processes.

Keywords: professional football, injury, evidence, media-based, severe injury, ACL

Introduction

Soccer is a highly popular sport with more than 200 million registered players around the world.[1] Soccer owes its popularity to various professional competitions such as FIFA soccer tournaments, the UEFA Champions League, and professional national competitions. Nowadays, soccer represents a multi-billion-dollar entertainment industry.[2–5] Marketing strategies in professional soccer involve high fees for television rights and ever increasing salaries for players and club staff. In the framework of these developments, professional soccer players are a crucial part and an essential product of the soccer industry. The playing time of the most successful soccer players greatly influences their success in sports. The popularity of soccer is not only apparent in football stadiums and the media but also in the importance for betting and gambling businesses.[6] Therefore, a player's absence

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from sports due to injury has not only consequences for the injured player but also for the club and the accompanying businesses; thus, any absence is consequently of great interest to soccer supporters and the sports world in general.[7,8]

Frequent reasons for absence from soccer are traumatic and overuse injuries or other medical problems of the players.[9] The circumstances of soccer injuries, injury severity, time of return-to-soccer, and long-term outcome have a crucial impact on injured players and their soccer clubs as well as on any other business involved in professional soccer (eg, player consultant, sponsorships, and betting and gambling businesses). In the past few years, more and more personal information about professional soccer players, particularly their medical and injury data, has been published by national and international media.[10,11] In the national media of Germany, several online platforms inform soccer supporters and the public about the injuries and medical problems of professional soccer players.[11] The injuries of professional soccer players are also published in the media of national sports medicine as well as in media-based scientific injury statistics.[6,11,12] Such media-reported injury data are also more and more used for injury statistics in scientific research.[6,12,13] In addition, professional soccer clubs also use such data for assessing the main medical problems of potential new soccer players for their clubs. Therefore, the accuracy and reliability of media-reported data may have an enormous impact on transfers and the careers of professional soccer players as well as on the decision-making process of stakeholders in the soccer industry. A recent study has published injury information about anterior cruciate ligament (ACL) injuries in professional soccer by means of a media-based injury sample.[14] But the validity of some of the published data is unclear so that the implementation of specific criteria is required.[14,15]

This study investigated for the first time the validity of published injury data of professional soccer players over one season (2015–2016). The objective of the current study was to find out if published injury data correspond with actual diagnoses. A further point of interest was the extent to which injuries may be published incorrectly or missing in the nation-wide media. The study addressed the questions if media-reported injury data may be used without limitation in scientific research projects or if the accuracy and reliability of such data should be increased by a verification process, and if the validity of severe soccer injuries such as ACL injuries differs to that of minor injuries.

Patients and Methods
Study Design

This prospective cohort study investigated the injury data of soccer players of the first and second professional German soccer league (Bundesliga) over one season (2015–2016). Professional soccer clubs of the first two leagues were prospectively and randomly selected and informed about the study design and the intention of the study, after which 12 teams agreed to participate in this study. Only teams with complete injury statistics for all players were included. Within these teams, only players were taken into account who had participated in at least one official match over the season. Injury registration was conducted on a weekly basis by means of the public online platform "www.transfermarkt.de", a national and international database for soccer players, team coaches, managers, and clubs to obtain information about specific elite soccer players. This platform was used to collect recently published media-based injury data.[12,13,15] The respective database also provided detailed information on players' soccer exposure per season, memberships in previous clubs, the level of competition, their current financial value, as well as details on their previous and current medical status.[13] Upon request, the platform providers stated that their published injury data were obtained from local, regional, and national public media and also included the time away from soccer until the next official match (rehabilitation time/time to return to play [RTP]).

At the end of the investigated soccer season, the injury statistics from the online database of each team was sent to the team physicians of the participating soccer clubs. Each club received one questionnaire per player to document every single injury of each player over the season. The respective team physician had to confirm or refute the media-reported injury and provide the researchers with the correct diagnosis of the injury (including details on the injured body site and the type of injury). At the end of the list of injuries documented within the database, the team physician was able to add any additional injuries of a player during the investigated soccer season that had not been published online ("if any") (missing injuries). After completion of the list, the team physician anonymized all injury data by removing the players' names from the documents. The anonymized documents were sent back to the study office. Identification of clubs or players by means of the questionnaire was not possible.

Statistical Analysis

The epidemiological injury data were assessed according to the international guidelines for injury statistics and data sampling in soccer established by Fuller et al (2006) and Hägglund et al (2005).[16,17] All relevant injury data available from the online database were documented: injury diagnosis, time away from soccer, played soccer level, age, height, dominant leg, and other details. The confirmation rate of the published injury data was calculated by means of the percentage of injury data confirmed by the team physicians.

The true incidence of all occurred injuries was calculated from the sum of all media-reported injuries and the number of injuries missing in the online database. The validity of overall injury statistics (in %) and of various specific types of injury and injured body sites was calculated by the number of confirmed injuries divided by the overall number of injuries (the sum of wrong, missing, and miscategorized or misdescribed media-reported injuries). Differentiating validity regarding specific body sites and injury types or diagnoses should clarify which soccer injuries may principally be suitable for scientific evaluation by means of media-based injury screening.

Continuous data are expressed as mean ± standard deviation (SD) and categorical data as frequency counts (percentages). The proportion of correct diagnoses, body sites, injury types, as well as overall validity between the first and second Bundesliga were compared with the Fisher's exact test. The significance level was set to $p<0.05$. All analyses were done with IBM SPSS Statistics, version 24.0 and R (version 3.3.3, The R Foundation for Statistical Computing).

Ethical Approval

The method of data sampling and anonymization as well as the general study design were approved by the Ethics Committee of the University of Regensburg (No.: 10-101-0037).

Results

Four teams of the first league and four teams of the second league, altogether consisting of 240 players, were included in this data analysis. Four teams were excluded from the study because of the failure to provide complete sets of injury data.

Media-Based Injury Statistics

The anthropometric data did not show any relevant differences between the two leagues (Table 1). For the 240 players of the first and second soccer league included in this investigation, 255 injuries in 136 players had been documented in publicly available media reports, resulting in an injury frequency of 56.7% and a mean injury occurrence of 1.06 per player over the course of the season (Table 2). According to these media reports, 25.4% of players had sustained repeated injuries over the soccer season. The most frequently injured body sites had been

Table 1 Media-Based Anthropometric Data of the Study Population

	First League (n=121)	**Second League (n=119)**	**Overall (n=240)**
Anthropometric data	**Mean/SD (range)**	**Mean/SD (range)**	**Mean/SD (range)**
Age (years)	24.3/± 4.2 (17–35)	24.1/±4.1 (17–37)	24.2/± 4.1 (17–37)
Height (cm)	183.1/± xx (166–196)	183.8/± xx (167–198)	183.5/±6.7 (166–198)
Soccer-specific data	**n (%)**	**n (%)**	**n (%)**
Position on field			
Keeper	13/121 (10.7%)	10/119 (8.4%)	23/240 (9.6%)
Defender	43/121 (35.5%)	38/119 (31.9%)	81/240 (33.8%)
Midfielder	40/121 (33.1%)	39/119 (32.8%)	79/240 (32.9%)
Striker	25/121 (20.7%)	32/119 (26.9%)	57/240 (23.8%)
Dominant foot			
Right	96/121 (79.3%)	93/119 (78.2%)	189/240 (78.8%)
Left	25/121 (20.7%)	26/119 (21.8%)	51/240 (21.2%)
Soccer exposure over one season in hours			
Overall match exposure	3939.5	3256.7	7196.2
Match exposure per player Mean/SD	32.56/± 17.7	27.37/± 14.6	29.98/± 16.4

Table 2 Media-Based Injury Data of the Study Population

	First League n (%)	Second League n (%)	Overall n (%)
Injury incidence			
Total number of players	121	119	240
Injured players	79/121 (65.3%)	57/119 (47.9%)	136/240 (56.7%)
Uninjured players	42/121 (34.7%)	62/119 (52.1%)	104/240 (43.3%)
Total number of injuries	171	84	255
Injuries per player	1.4	0.71	1.06
Injury site			
Head	6/171 (3.5%)	0	6/255 (2.4%)
Shoulder	5/171 (2.9%)	2/84 (2.4%)	7/255 (2.7%)
Wrist	1/171 (0.6%)	1/84 (1.2%)	2/255 (0.8%)
Hand	2/171 (1.2%)	1/84 (1.2%)	3/255 (1.2%)
Back or trunk	8/171 (4.7%)	6/84 (7.1%)	14/255 (5.5%)
Hip or groin	17/171 (9.9%)	11/84 (13.1%)	28/255 (11.0%)
Thigh	52/171 (30.4%)	13/84 (15.5%)	65/255 (25.5%)
Knee	30/171 (17.5%)	25/84 (29.8%)	55/255 (21.6%)
Shank	15/171 (8.8%)	4/84 (4.8%)	19/255 (7.5%)
Ankle	12/171 (7.0%)	13/84 (15.5%)	25/255 (9.8%)
Foot	11/171 (6.4%)	2/84 (2.4%)	13/255 (5.1%)
Others	12/171 (7.0%)	6/84 (7.1%)	18/255 (7.1%)
Type of injury			
Strain	30/171 (17.5%)	15/84 (17.9%)	45/255 (17.6%)
Ligament rupture	15/171 (8.8%)	20/84 (23.8%)	35/255 (13.7%)
Muscle-fiber rupture	17/171 (9.9%)	8/84 (9.5%)	25/255 (9.8%)
Fracture	8/171 (4.7%)	7/84 (8.3%)	15/255 (5.9%)
Sprain	15/171 (8.8%)	6/84 (7.1%)	21/255 (8.2%)
Joint dislocation	1/171 (0.6%)	0 (0%)	1/255 (0.4%)
Contusion	28/171 (16.4%)	5/84 (6%)	33/255 (12.9%)
Overuse injuries	40/171 (23.4%)	17/84 (20.2%)	57/255 (22.4%)
Others	17/171 (9.9%)	6/84 (7.1%)	23/255 (9.0%)
Athletic deficit/sport-specific reason	37/171 (21.6%)	1/84 (1.2%)	38/255 (14.9%)
Severity of injury			
Slight injury (<1 week)	64/171 (37.4%)	12/84 (14.3%)	76/255 (29.8%)
Moderate injury (1–4 weeks)	54/171 (31.6%)	25/84 (29.8%)	79/255 (31.0%)
Severe injury (>4 weeks)	53/171 (31.0%)	47/84 (55.9%)	100/255 (39.2%)

the thighs and the knee joints, and the most common types of injury strain and overuse complaints (Table 2).

Validity of Media-Based Injury Data and Missing Diagnoses

Of 255 media-reported injuries, 146 were confirmed by team physicians, yielding a rate of 57.3% of correct media-reported diagnoses, but 109 injuries had an incorrect diagnosis (42.7%). The highest validity was seen in severe injury types such as joint dislocations (100.0%), ligament ruptures (82.9%), fractures (73.3%), and particularly knee injuries (78.2%). The injuries with the lowest

validity were foot injuries (46.2%), contusions (54.5%), and overuse injuries (52.6%) (Table 3).

Next to the 255 media-reported injuries, the injury lists provided by the team physicians yielded 92 further injuries. When taking into account both media-reported injuries and injuries additionally registered by the participating team physicians, the correct overall numbers were 347 injuries per season and 1.45 injuries per player (255 media-reported injuries plus 92 injuries missing in the media). The overall validity of the publicly available injury statistics was 42.1% (146 veritable injuries divided by 347 overall injuries). Therefore, the overall validity of

Table 3 Overall Validity of Media-Based Data and Missing Injuries

	Media-Reported Injuries – Correct Diagnosis Verified by Team Physicians n=146	Media-Reported Injuries – Incorrect Diagnosis n=109	Missing Injuries in Media Reports n=92
Injury site n (%)			
Knee	43/55 (78.2%)	12/55 (21.8%)	13/92 (14.1%)
Hip or groin	22/30 (73.2%)	8/30 (76.8%)	7/92 (7.6%)
Ankle	17/25 (68%)	8/25 (32%)	12/92 (13.0%)
Upper extremity	8/12 (66.7%)	4/12 (33.3%)	8/92 (8.7%)
Head	4/6 (66.7%)	2/6 (33.3%)	3/92 (3.3%)
Thigh	42/65 (64.6%)	23/65 (35.4%)	18/92 (19.6%)
Back or trunk	10/14 (71.4%)	4/14 (28.6%)	2/92 (2.2%)
Shank	9/19 (47.4%)	10/19 (52.6%)	14/92 (15.2%)
Foot	6/13 (46.2%)	7/13 (53.8%)	15/92 (16.3%)
Type of injury n (%)			
Joint dislocation	1/1 (100%)	0/1 (0)	5/92 (5.4%)
Ligament rupture	29/35 (82.9%)	6/35 (17.1%)	5/92 (5.4%)
Fracture	11/15 (73.3%)	4/15 (26.7%)	1/92 (1.1%)
Muscle rupture	22/35 (62.9%)	13/35 (37.1%)	3/92 (3.3%)
Strain	26/45 (57.8%)	19/45 (42.2%)	16/92 (17.4%)
Sprain	12/21 (57.1%)	9/21 (42.9%)	7/92 (7.6%)
Contusion	18/33 (54.5%)	15/33 (45.5%)	53/92 (57.6%)
Overuse injuries	30/57 (52.6%)	27/57 (47.4%)	2/92 (2.2%)

media-reported injuries was weak. Missing injuries analyzed with regard to the type of injury were mainly contusion (57.6%) and strains (17.4%) and with regard to the injury site lesions in the thighs (19.6%) and the feet (16.3%). In the case of fractures, the number of missing injuries was very low (1.1%; Table 3).

Individual team analysis yielded a heterogenic, team-dependent validity of media-reported injury data. One team showed a high injury validity of 72.7%, another team a lower validity of 27.6% because of missing injuries in the online data base (Table 4). Significant differences were found between the different soccer leagues. The second league had higher validity regarding correct injury diagnosis (p=0.047), missing injuries, and overall correct injury validity (p=0.001).

Reporting and Diagnostic Validity of the Most Common Injuries in Soccer

This study yielded different validity rates for typical soccer injuries reported in the media. Media-reported ACL injury data showed a validity of 100% and no missing injuries, whereas other typical football injuries

such as thigh muscle strains were only valid in 58.8% of cases (Table 5).

Discussion

The most important finding of this study is that the validity of media-reported injury data in national professional soccer is lower than 50% for all types of injury. The accuracy of validity rates depends on the severity of the injury, for instance, the validity of media-reported severe knee injuries such as ACL ruptures is rather high. These results have direct consequences for the interpretation of media-based injury data and show the need for clear criteria in daily soccer routine and scientific research.[15] Particularly less severe injuries such as contusion are marked by weak validity and a high number of injury data missing in the media. Data on less severe injuries obtained from media-based injury reports can therefore not be recommended for direct use in research projects such as epidemiological injury studies. Only typical severe injuries with longer time away from soccer show sufficient validity in the media presentation. ACL injuries had 100% validity with correct diagnosis and no missing injuries in this study; media-reported data on other knee ligament injuries such as to the MCL and LCL also had sufficient validity (>90%). The sufficient validity of media-reported ACL injuries represents an expected result because of the high incidence and importance of this type of injury in soccer.[8,9,18,19] Similar encouraging validity results were seen in other severe types of injuries such as fractures of the upper extremity, whereas the validity of other soccer injuries such as thigh muscle strains was weaker.

As a first consequence of this study, using media-based data for valid injury analyses can only be recommended for ACL injuries and to some extent for other severe types of injury such as ligament ruptures or bone fractures. Nevertheless, the use of media-based injury data can only be scientifically justified if specific data collection and registration criteria are met, even in the case of severe types of injury.[15]

Knowledge about the actual injury diagnoses and the validity of media-reported injury data should not weaken the conclusions of previously published injury investigations based on media data. However, the results of this study may be useful for a better understanding and interpretation of future projects based on such data. The national data sample of ACL injuries in soccer obtained from publicly available injury reports represents a first step in this direction.[20] A successful media-based analysis of

Table 4 Comparison Between Professional Soccer Teams of the First and Second Football League with Regard to Validity and Missing Injury Data

	First League n (%)					Second League n (%)				
	Team 1	Team 2	Team 3	Team 4	Overall	Team 1	Team 2	Team 3	Team 4	Overall
Overall validity of injuries										
Correct diagnosis	30/42 (71.4%)	28/48 (58.3%)	26/52 (50.0%)	8/29 (27.6%)	92/171 (**53.8%**)	8/11 (72.7%)	24/37 (64.9%)	11/17 (64.7%)	11/19 (57.9%)	54/84 (**64.3%**)*
Correct body site	31/42 (73.8%)	28/48 (58.3%)	32/52 (61.5%)	11/29 (37.9%)	100/171 (58.5%)	9/11 (81.8%)	28/37 (75.7%)	15/17 (88.2%)	14/19 (73.7%)	66/84 (78.6%)
Correct injury type	32/42 (76.2%)	33/48 (68.8%)	27/52 (51.9%)	9/29 (31%)	101/171 (59.1%)	10/11 (90.9%)	25/37 (67.6%)	13/17 (76.5%)	11/19 (57.9%)	59/84 (70.2%)
Missing injuries	0	5	16	67	88	2	0	1	1	4
True number of injuries	42	53	68	96	259	13	37	18	20	88
Overall validity	30/42 (71.4%)	28/53 (52.8%)	26/68 (38.2%)	8/96 (8.3%)	92/259 (**35.5%**)	8/13 (61.5%)	24/37 (64.9%)	11/18 (61.1%)	11/20 (55%)	54/88 (**61.4%**)**

Notes: *p=0.047, **p=0.001; bold: comparison of the validity between the leagues.

Table 5 Time of Return-to-Competition of Valid Data on Typical Soccer Injuries

Diagnosis	Validity of Online Data	Missing Diagnoses	Time Away from Soccer (In Days, SD)
ACL injury	4/4 (100%)	0	266 days (±216.04)
Upper extremity fracture	6/6 (100%)	0	54 days (±19.27)
MCL and LCL injury	12/13 (92.3%)	2	55 days (±34.06)
Meniscus	4/5 (80%)	2	71 days (±24.98)
Thigh muscle rupture	18/25 (72%)	3	28 days (±15.08)
Lower extremity fracture	5/7 (71.4%)	1	121 days (±97.05)
Ankle ligament rupture	10/14 (71.4%)	4	37 days (±32.61)
Achilles tendon injury	2/3 (66.7%)	1	192 days (± 12.02)
Thigh muscle strain	20/34 (58.8%)	7	7 days (±7.5)

Abbreviations: ACL, anterior cruciate ligament; MCL, medial collateral ligament; LCL, lateral collateral ligament.

specific soccer injuries requires the selection of not only the correct injury diagnosis, but also the confirmation of these data by means of specific standardized and validated confirmation protocols. This step should include a verification process of media-based injury diagnosis by other media reports. Additionally, advanced media analysis should include only validated parameters for personal data, influencing factors for potential injury risk profiles, and injury outcome information. Typical highly valid data to be obtained from media-based analysis in professional soccer are for instance anthropometric player data, the body site affected by injury, the level of competition, and the day of return to competition. Less valid media-based data are for instance concomitant lesions, injuries, comorbidities, injury mechanisms, and training performance.

Because of the questionable validity, media-based analyses using these parameters should not be used for scientific purposes.

Because of the lack of official injury statistics on the German Bundesliga and many other European soccer leagues, media-reported data have been methodologically used for scientific research projects with the result of potentially inaccurate data.[10–12,14,15]

The public availability of personal and medical data of professional soccer players should be discussed in society and in the soccer community in the future. On the one hand, soccer players have a right to privacy of their medical data; therefore, publishing these data is only possible with the full consent of the player.[21,22] Team physicians and physiotherapists are not − or only to a very limited

extent – allowed to make these data known to the public without the consent of the club or the team coach as the employer of the player. Personal data are often released to the public by members of the club, particularly by press officers or other club officials. Clubs have to balance the necessity of informing the public about the injuries of a player to explain their absence from professional soccer with respecting the player's right to privacy.[21,22]

This study shows that information on injuries of professional soccer players is frequently not correctly passed on to the public. Reasons for this inconsistent information transfer may be simplification of the medical language regarding diagnosis, mistakes in the data transfer, or the decision of a soccer club or player to disallow or change the information transferred to the public. One important reason for the intentional concealment of injuries is that a player's performance may be weakened in physical duels during the match if opponents know about the injury. After an injury, typically after toe or rib fractures, professional soccer players often just take pain medication and continue playing because of time pressure.[23,24] In such cases, the diagnosis should remain within the team to protect the player against intentional contacts by opponents during the subsequent matches.

On the other hand, the public has a great interest in receiving detailed information about any injury of professional soccer players. The media, in particular the social media, want to publish headlines about the injuries of popular athletes.[25,26] Moreover, other business sectors involved in professional soccer are also interested in such data. One large sector is the betting and gambling industry because injuries of important players may have a large impact on the betting scores of a match.[27–29] The soccer community also benefits from detailed knowledge about specific injuries of players, for instance, if a soccer club wants to sign on a player. In professional soccer, team physicians and medical staff routinely collect information about soccer players before signing them on. Therefore, these data are easily obtained from an online database. Modern online technology may have a negative impact in some cases but may also play its part in injury prevention and the development of novel study designs.[15,30] The results of the injury statistics in this study were comparable to those of other epidemiological injury surveys on professional soccer.[7,9,18,31] The validity rates of the most frequent types of injury and the most frequently injured body sites in this study were comparable to those described in the literature.[7,9,18,31]

This study is the first assessment of the validity of media-reported injuries in professional soccer, but it is not without limitations. The first limitation is the low number of participants compared to other epidemiological injury surveys on national professional soccer leagues. This low number was a consequence of the ethical guidelines for the verification of publicly known injury data as well as of the strict exclusion criteria leading to the exclusion of 4 teams. But such strict exclusion criteria are essential for ethical guidelines. The second reason for the low rate of participation in such a unique study design is the typically lower rate of response in professional soccer and also the potential confrontation of clubs and medical staff with verified and publicly available injury data. The publication of medical data of soccer players by club officials is a controversial topic, because players have patients' rights to professional secrecy just as any other patient. The injury statistics of this study show for the first time the general discrepancy between published and actually occurred injuries in professional soccer.

The question of this study if media-reported data correspond with truly occurred injuries or if such data need specific criteria for scientific use has been clearly answered by this data sample. But further studies on this topic are necessary to elaborate criteria and verification processes for assessing more accurate injury data. This study has shown an overall weak validity of media-reported injury data in professional soccer that may influence the interpretation of scientific and media-based injury statistics. ACL injuries are veritably published in the media and therefore suitable for scientific injury statistics in professional soccer, but only if injury analysis protocols respect the weakness of media-based data and if specific criteria are applied.[15]

Conclusion

General and uncritical use of media-based injury data of professional soccer players are not recommended for scientific research. Publicly available injury data were only valid for a few severe types of injury such as ACL injuries. Less severe media-reported injuries had weak validity because of a considerable proportion of missing data and incorrect diagnoses. For further scientific use, a verification process of media-based injury data is indispensable.

Disclosure

Werner Krutsch reports being a member of medical committees in different football associations: German Football Association, German Football League and Bavarian

Football Association but states all memberships are no conflict of interest to this study and this article. The authors report no other conflicts of interest in this work.

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